

Anatomy, Ecology and Distribution of the Volutidae and Volutomitridae of the Southern Indian Ocean

(Gastropoda: Prosobranchia)

BY

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(1 Plate; 10 Text figures)

THREE RECENT BENTHIC SURVEYS have been done with the M/S *Marion-Dufresne* in the subantarctic waters of the Indian Ocean. During cruise MD.03 (1974) several stations were made (including 50 macrobenthic samples) off Kerguelen, Heard and Crozet Islands between shallow water and 4200 m. Cruise MD.04 (1975) concentrated on the shelf around Kerguelen Islands, with 231 macrobenthic samples, and cruise MD.08 was mostly concerned with the Marion-Prince Edward shelf (49 macrobenthic samples) and the Crozet shelf (99 macrobenthic samples).

We collected 3 species of volutid and volutomitrid gastropods at 65 stations, in 73 samples, by trawls, dredges and grabs (Table 1): *Provocator pulcher* Watson, 1882; *Volutomitra curta* (Strebel, 1908) and *V. fragillima* Watson, 1882 (Figures 1 to 3). Study of the plentiful specimens provides the first thorough insight into these 2 allied neogastropod families in this area. Many faunistic and biogeographic data are recorded and the resulting distribution of the 3 species obtained is mapped (Figures 7, 8). Our anatomical studies, made with the help of D. van Weert, have led to discussion of several of their characteristics and assessment of their positions in the 2 families involved. The egg capsule of the volutid *Provocator pulcher* is also described and figured for the first time.

Family Volutidae

Provocator pulcher Watson, 1822

Provocator pulcher WATSON, 1882: 330, 331; 1886: 260, pl. 13, fig. 5; CARCELLES, 1947: 6; POWELL, 1960: 156; WEAVER & DUPONT, 1970: 123, fig. 53 F-G; CLOVER, 1975a: 10, 1 photo; 1975b: 1, 1 photo
Provocator provocator SOWERBY, 1887: 305, pl. 18, fig. 176; SMITH, 1942: 62, 63, pl. 13, fig. 95
Zidona (Provocator) pulchra. WENZ, 1943: 1350, fig. 3822

Specimens (empty shells recorded in parentheses):

- Kerguelen Islands

MD.03: 7-CP4, 3; 11-CP7, (2); 13-CP9, 3; 17-CB5, 12 (3); 21-CP14, 5 (2); and 2 egg capsules (incl. 1 empty); 24-CB6, 5 (1)

MD.04: 7-CP13, 1 (2); 26-CP61, 2; 34-DC88, (1); 35-DC89, 1; 38-CP92, 1; 39-DC93, (1); 45-DR106, (2); 70-CP169, 1 egg capsule; 95-DC233, 1 egg capsule; 118-CP284, 1 (1)

- Crozet Islands

MD.08: 42-CP197, (1); 75-CP303, (3); 78-CP319, (2)

Distribution (Figures 7, 8):

The type locality is Kerguelen Islands, West Christmas Harbour, 48°43'S; 69°15'E, 105 fathoms [190m], volcanic mud. Previously known only by empty shells (WATSON, 1882) and by shells from unknown stations off Kerguelen (CLOVER, 1975a, 1975b), the species is here re-



Figure 7

Present records of Volutidae and Volutomitridae off Kerguelen Islands and Heard Island: *Provocator pulcher* (1: living; 2: dead; 3: egg capsule), *Volutomitra fragillima* (4: living; 5: dead) and *Volutomitra curta* (6: living; 7: dead)

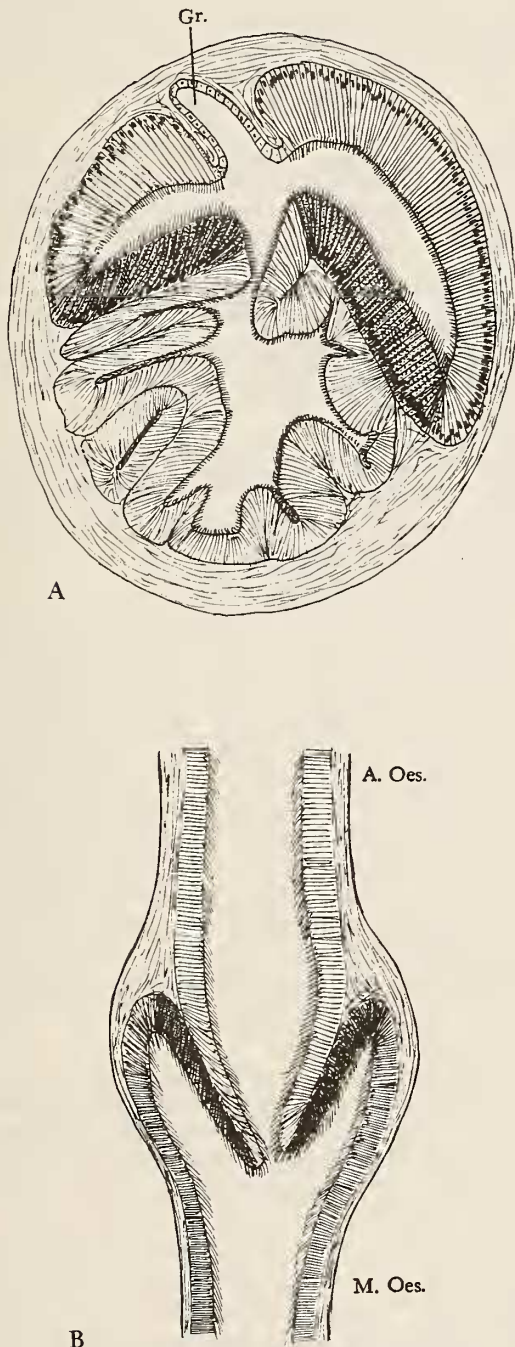


Figure 13

Provocator pulcher: valve of Leiblein; A, frontal section; B, transversal section A. Oes. - anterior oesophagus Gr. - non-ciliated groove M. Oes. - mid-oesophagus

When crossing the nerve ring, the mid-oesophagus has a diameter of about 1.5 mm. Its walls are thin. The muscular layer is very weak at its beginning, the fibers have the same disposition as in the anterior part. The external layer of circular muscle fibers is thicker. The inner epithelium forms a few low ridges. At a short distance from the beginning, the gland of Leiblein (Figure 11) begins with swellings that appear on the dorsal wall of the oesophagus. The gland is progressively differentiated as a tubular, elongate organ coiled upon itself in a compact mass surrounding the oesophagus. The lumen is alveolar with muscular compartments. The gland is composed of 3 distinct parts. The first is lined with tall columnar gland cells with few mucocytes; the muscular layer is very thin. In the next part, the wall has a thick muscular layer and bears longitudinal and transverse ridges. The glandular epithelium is composed of a higher percentage of mucocytes. The dead end of the gland forms a sac 2 to 2.5 mm wide. Its wall is very thin and lined in most of its parts by a flattened epithelium. There are a few scattered low ridges of gland cells comprising some mucocytes. The bad fixation of the tissues in this part of the digestive tract prevented better interpretation.

Unidentified food remnants have been found in this part of the alimentary canal. Behind the gland of Leiblein, the posterior part of the mid-oesophagus has a diameter of 1.9 mm; its internal wall bears many longitudinal ridges.

The posterior oesophagus is separated from the preceding part by a constriction. Its section increases rapidly to a diameter of 2 to 2.5 mm. The muscular layer is very thin, the epithelium consists of ciliated cells and mucocytes. There are digitated internal ridges.

The U-shaped stomach is a very simple sac with an internally plicated wall. The ridges of the dorsal part of the posterior oesophagus reach the single digestive gland aperture. The ventral ridges continue in the intestine without interruption.

The intestine runs from the stomach along the right pallial wall. Its diameter is 2 to 3 mm. The thin muscular layer is lined with an epithelium which is thickened into longitudinal ridges of columnar, ciliated gland cells with numerous dark granules. The mucocytes, scattered at the beginning, are much more abundant towards the end. The anal gland is a branching tubule derived from an invagination of the renal wall. Its cells are ciliated and granular.

Discussion: With these observations, it is possible to determine the systematic position of the genus *Provocator*. This genus has been classified in the subfamily Zidoninae by CLENCH & TURNER (1964) on the basis of the morpho-

logy of the radula. This placement is corroborated by the following observations:

- uniseriate radula with tricuspid teeth;
- accessory salivary glands loosely bound around moderately compact salivary glands;
- lobes at the bases of the siphon of equal development;
- absence of operculum.

It should be added that the genus *Provocator* could be considered more primitive than *Alcithoe* by the fact that its gland of Leiblein is less detached from the oesophageal wall than in the latter genus (compare the anatomical description of *Alcithoe arabica* by PONDER, 1971).

On the specific level, the very close similarity should be noted between the radular teeth of *Provocator pulcher* (Figure 12A) and *P. corderoi* (cf. pl. 107 in CLENCH & TURNER, 1964); the teeth of the latter species are somewhat more slender, with more arcuate bases.

Family Volutomitridae

Volutomitra curta (Strebel, 1908)

Paradmete curta STREBEL, 1908: 23, pl. 3, figs. 34a-e; POWELL, 1951: 166; CARCELLES, 1953: 196; POWELL, 1958: 198; 1960: 157

Paradmete longicauda STREBEL, 1908: 24, pl. 3, figs. 36a-b; POWELL, 1951: 165; CARCELLES, 1953: 196, pl. 3, fig. 70

Volutomitra (Paradmete) curta. CERNOHORSKY, 1970: 103, pl. 13, figs. 11-13

Specimens (all from Kerguelen Islands):

MD.03: 3-CP2, 6 (1); 3-DS1, 1; 6-CP3, 3; 17-CB5, 70 (9); 21-CP14, 1; 24-CB6, 2

MD.04: 15-DC37, 1; 17-DC39, 1; 24-DR58, 1 (2); 38-CP92, 1; 47-DC108, 1; 82-CP196, (1); 113-DC269, (1); 115-DC275, 1

Distribution: The type locality is Shag Rock Bank, 53° 34'S, 43° 23'W, 160 m, gravel and sand, bottom temperature +2.05°C. It was known from Shag Rock Bank,

South Georgia Island, Enderby Land, Mackenzie Sea. First recorded here (cf. Figure 7) from Kerguelen Islands, a major northward extension of range of this volutomitrid. Not obtained at Crozet Islands or Marion/Prince Edward Islands during our surveys.

Bathymetric Range: Was known living from 75 to 300 m. Thus it is of interest to point out that this species was obtained living off Kerguelen Islands from 120 m to as deep as 650 m (present material).

Ecology: Rather similar to that of *Volutomitra fragillima* (the 2 species are frequently collected together) but with a lower temperature-tolerance which would account for its absence from both the Crozet and Marion/Prince Edward shelves.

Anatomy (Figures 14, 15): Animal rather small; maximum height of the shell: 28.6 mm. Tentacles cylindrical, bearing eyes on their posterior side. Operculum present.

The Alimentary Canal:

The pleurembolic proboscis is relatively long. The wall of the proboscis sheet is transversely plicate. The strong retractor muscles connect its sides to the lateral walls of the body. The ventral wall of the buccal cavity is protected by a chitinous shield. The accessory salivary gland is an unpaired organ as in other Volutomitridae. This gland is quite small and entirely concealed in the proboscis. Its thin secretory duct lies just behind the chitinous shield of the buccal floor and opens at the mouth aperture. Histologically the gland consists of a tube lined with cubic epithelium, the cells possessing large nuclei, and an outer layer of circular muscle fibers. Few gland cells are situated in its terminal part. The radula is triseriate. The central tooth is quite large with a single thin lanceolate cusp and 2 long basal processes (Figure 12C). The lateral teeth are small and short.

The salivary glands are small; the secretory tubules are composed of one type of cell. The salivary ducts enter the wall of the oesophagus in front of the valve of Leiblein. They open into the buccal cavity close to the junction of

Explanation of Figures 1 to 6

Figure 1: *Provocator pulcher*, height 85 mm, from Kerguelen Islands, MD. 03-24-CB6

Figure 2: *Volutomitra curta*, height 15.6 mm, from Kerguelen Islands, MD. 03-17-CB5

Figure 3: *Volutomitra fragillima*, height 15.4 mm, from Kerguelen Islands, MD. 04-F51-DC119

Figure 4: Egg capsule of *Provocator pulcher* on a valve of *Malletia gigantea* measuring 47 × 28 mm; Kerguelen Islands, MD 04-H95-DC233

Figure 5: Two egg capsules of *Provocator pulcher* on an egg capsule of skate, Kerguelen Islands, MD. 03-21-CP14

Figure 6: The same capsules, enlarged

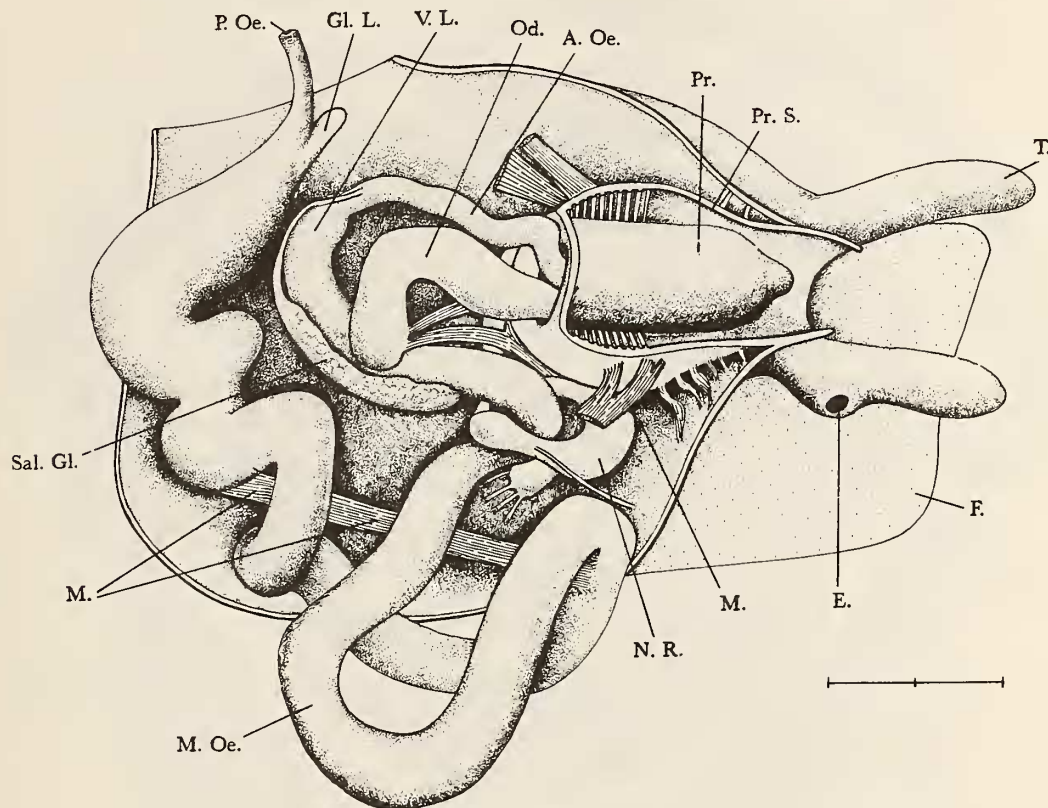


Figure 14

Volutomitra curta: anterior part of the digestive tract. Abbreviations as for Figure 11. E - eye M - muscular bundles

the oesophagus. The ducts are densely ciliated, the cilia having a forward orientation.

The anterior oesophagus is relatively narrow. There are 2 lateral ciliated ridges. Ventrally the epithelium is composed of flattened, nonciliated cells. Gland cells filled with red granules are in all this part of the digestive tract.

The mid-oesophagus begins with the valve of Leiblein. The tract is rather long and coiled upon itself, a strong muscular bundle is attached between 2 loops. The valve of Leiblein, situated well in front of the nerve ring, is quite typical. The ventral non-ciliated groove of the anterior oesophagus persists as a deep slit into the fold of the valve. This groove, ventral in the anterior part of the valve, moves progressively to the right and becomes dor-

sal posteriorly. This evidence of torsion thus occupies the same level as in the Volutidae. Two bundles of longitudinal muscle fibers are developed into the wall of the valve, below the ridges lining the non-ciliated groove. The histological organisation of the valve corresponds to the one observed in *Provocator*, except the 2 conspicuous muscular bundles present in its walls. The mid-oesophagus possesses a ciliated groove which corresponds to the pretorsional dorsal alimentary tract of the anterior oesophagus. At its beginning, the wall of the mid-oesophagus is thin; later on, it becomes thicker by increase of the internal layer of circular muscle fibers. The numerous mucocytes and the red-stained cells that constitute the dorsal epithelium of the first part of the mid-oesophagus are pro-

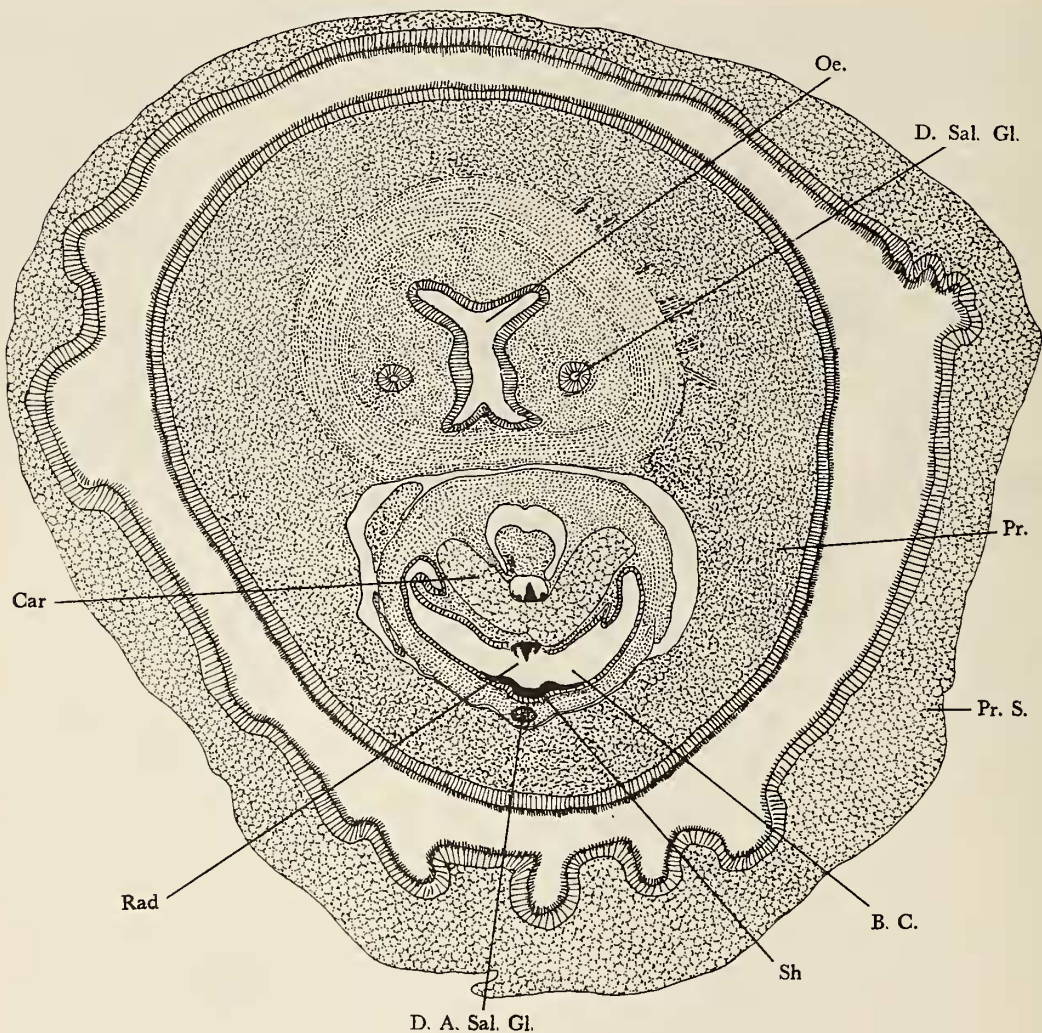


Figure 15

Volutomitra curta: transverse section through proboscis.

B. C. - buccal cavity Car. - subradular cartilage D. A. Sal. Gl. - common duct of accessory salivary glands Rad. - radula
 Oe. - oesophagus Pr. - proboscis Pr. S. - proboscis sheet

gressively replaced by gland cells of irregular shape and filled with brown granules. These latter elements are restricted to the dorsal part of the lumen and are separated from the ventral ciliated groove by 2 low ciliated ridges. Further on the dorsal part is completely isolated and forms the gland of Leiblein. At its posterior end, the gland emerges out of the wall of the mid-oesophagus as a small

translucent vesicle. Its histology seems to be uniform.

The transition from the mid-oesophagus to the posterior oesophagus is visible externally as a rapid decrease in the external diameter of the duct. Nevertheless, the size of the lumen remains constant, as there is a considerable diminution of the muscular layers of the wall. The lumen is lined with ciliated epithelium.

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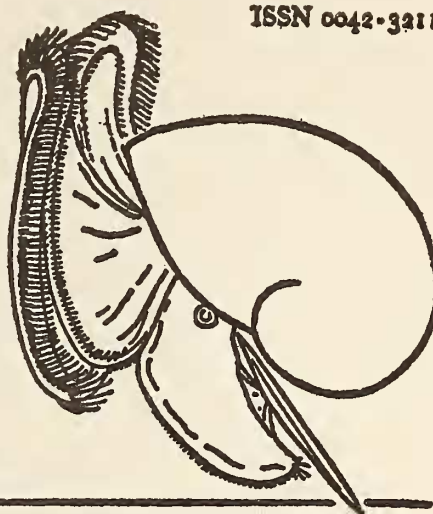
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Note: The various taxa above species are indicated by the use of different type styles as shown by the following examples, and by increasing indentation.

ORDER, Suborder, DIVISION, Subdivision, SECTION,
SUPERFAMILY, FAMILY, Subfamily, *Genus*, (*Subgenus*)
New Taxa

Egg Masses of Mollusca from Mediterranean Waters of Israel and Notes on Reproduction of the Freshwater Species

Theodoxus jordani and *Melanoides tuberculata*

BY

AL. BARASH AND Z. ZENZIPER

(14 Plates; 1 Text figure)

INTRODUCTION

A SERIES OF PAPERS on the molluscan fauna of the Mediterranean coasts of Israel has been published during the last decades. But only a few observations deal with the reproduction of Mollusca in this area (BARASH & DANIN, 1973; RAHAT, 1973). The purpose of the present work is to give a preliminary report on egg masses of marine molluscs found in the intertidal and infralittoral zones of the Mediterranean Israel and Sinai Peninsula. The Mediterranean coast, along which the material discussed here was collected, extends from Rosh-Haniqra in the North (Lebanon border) to Bardawil (Sinai Peninsula), near the northern entrance of the Suez Canal (see map).

Most egg masses were collected during field trips and expeditions, some were brought after months and even years of having been preserved in alcohol; accurate counting and measuring thus were often beyond our reach. In several cases, adult parent animals were put into aquaria, where they deposited their spawn, thus confirming the identity of the egg masses found in the sea. These included: *Cerithium scabridum*, *C. rupestre*, *Columbella rustica*, *Bulla striata*, *Aplysia fasciata*, *Bursatella leachi savigniana*, *Elysia timida*. The spawn of *Rhinoclavis kochi* was found only in the aquarium.

Egg masses were first sent for identification in 1966 to the late Professor Gunnar Thorson at the Zoological Museum of the University of Copenhagen. Unfortunately, his death interrupted his great scientific work and the material was returned to us containing identified egg masses of 6 species. Dr. Klaus Bandel, Friedrich-Wilhelms University, Bonn, identified egg masses of 5 species, and Dr. Nellie B. Eales, University of Reading, identified the egg masses of 2 species of Aplysiidae.

The greatest part of the material is kept in the collection of the Tel-Aviv University, Department of Zoology. The egg masses of *Cerithium rupestre* and *Elysia timida* are in the collection of the Hebrew University of Jerusalem, Department of Zoology.

The localities in which living adult specimens of the species treated in this paper were found are indicated; the vertical distribution of the species is also given. These data should be useful for future investigations of spawn of these species in the area.

LIST OF SPECIES CONSIDERED

GASTROPODA

PROSOBRANCHIA

MESOGASTROPODA

CERITHIIDAE

Cerithium scabridum Philippi, 1849

Cerithium rupestre Risso, 1826

Rhinoclavis kochi (Philippi, 1848)

JANTHINIDAE

Janthina ? nitens Menke, 1828

NATICIDAE

4 types, species not determined

CASSIIDAE

Cassidaria echinophora (Linnaeus,
1758)

Semicassis undulata (Gmelin, 1791)

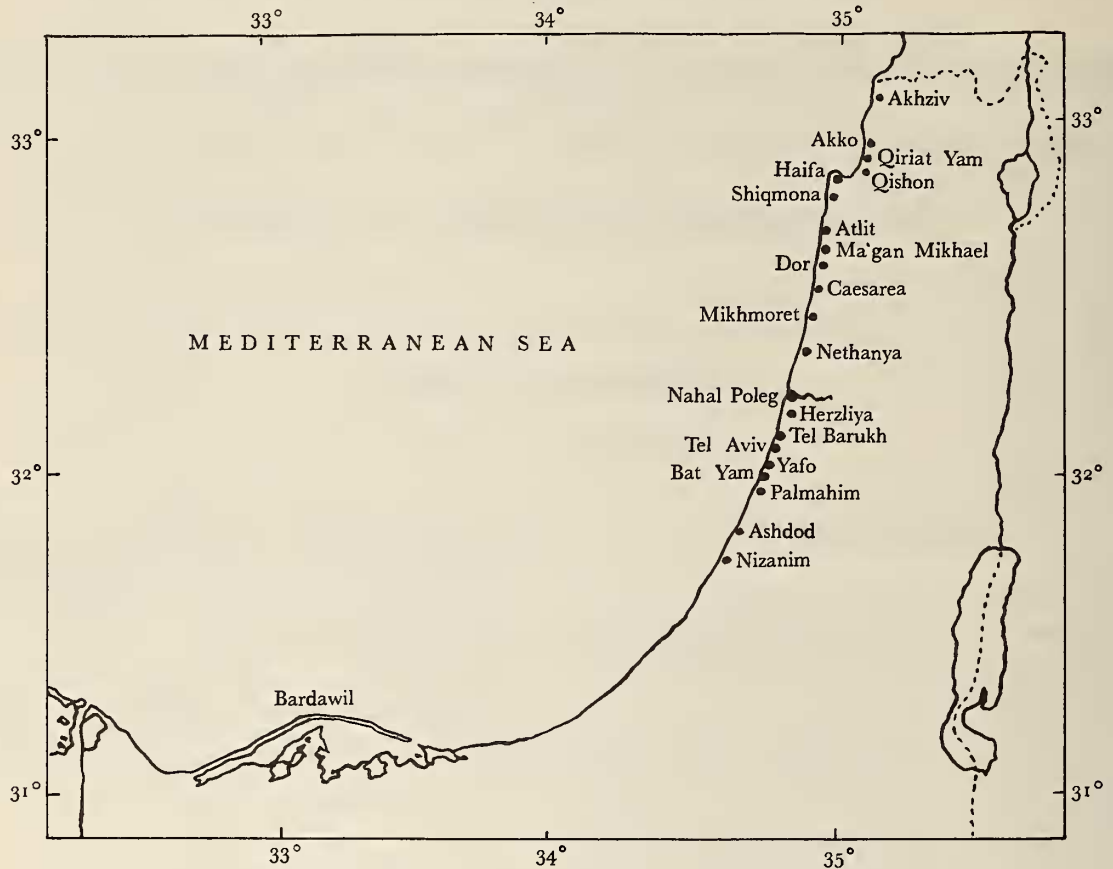


Figure 33

Collecting Localities of Molluscan Egg Masses at the Coasts of Israel and the Sinai Peninsula

TONNIDAE

Tonna galea (Linnaeus, 1758)

NEOGASTROPODA

MURICIDAE

Trunculariopsis trunculus (Linnaeus, 1758)
Murex brandaris Linnaeus, 1758

THAIDIDAE

Thais haemastoma (Linnaeus, 1767)
Thais carinifera (Lamarck, 1822)

COLUMBELLIDAE

Columbella rustica (Linnaeus, 1758)

BUCCINIDAE

Euthria cornea (Linnaeus, 1758)

Pisania striata (Gmelin, 1791)

NASSARIIDAE

Sphaeronassa mutabilis (Linnaeus, 1758)

FASCIOLARIDAE

Fasciolaria lignaria (Linnaeus, 1758)

CONIDAE

Conus ventricosus Gmelin, 1791

OPISTHOBRANCHIA

CEPHALASPIDEA

(Bullomorpha)

BULLIDAE

Bulla striata Bruguière, 1789

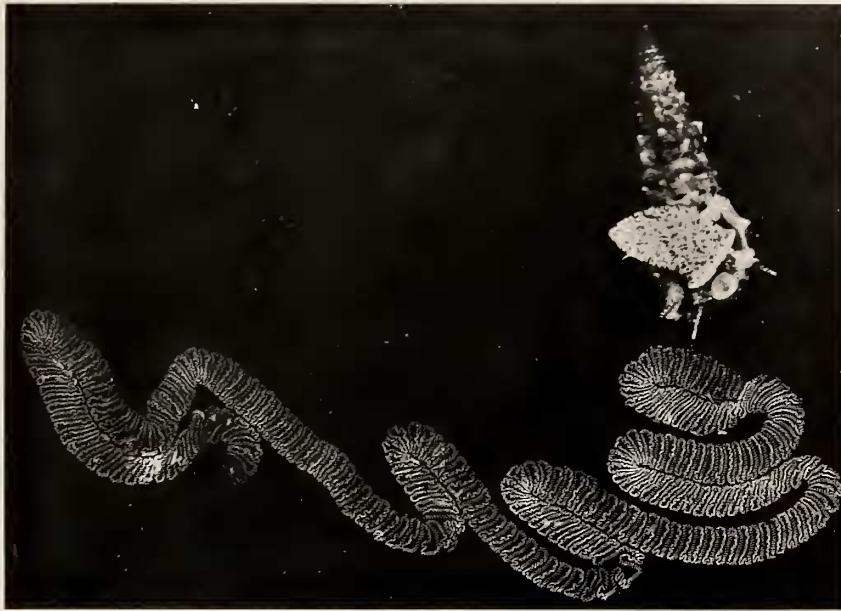


Figure 1



Figure 2

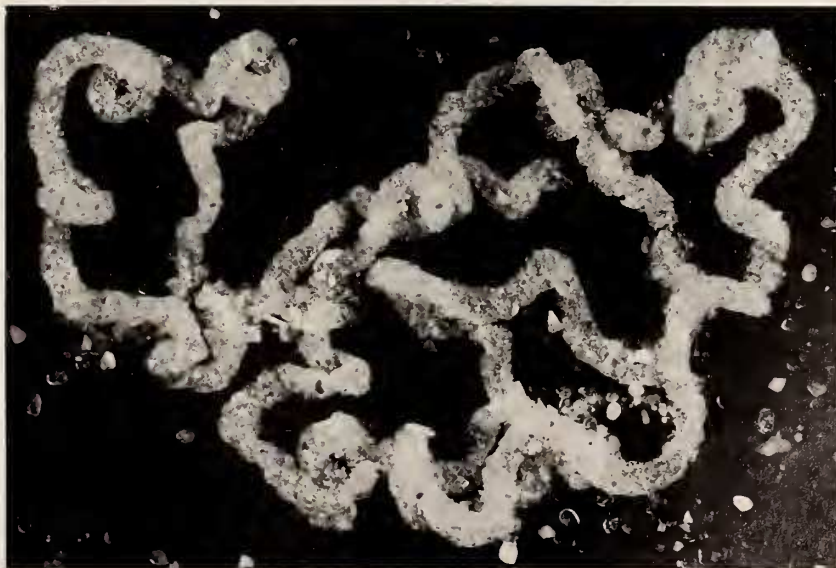


Figure 3